Chapter 4. Sediment Characteristics

INTRODUCTION

Ocean sediment samples are collected and analyzed as part of the South Bay Ocean Outfall (SBOO) monitoring program to characterize the surrounding physical environment and assess general sediment conditions. These conditions define the primary habitat for benthic invertebrates that live within or on the surface of sediments and can influence their presence and distribution. In addition, many species of demersal fish are associated with specific sediment types that reflect the habitats of their preferred prey (Cross and Allen 1993). Both natural and anthropogenic factors affect the composition, distribution and stability of seafloor sediments.

Natural factors that affect sediment conditions on the continental shelf include the strength and direction of bottom currents, exposure to wave action, seafloor topography and proximity to geographic features such as submarine basins, canyons and hills, inputs associated with outflows from rivers and bays, beach erosion and runoff from other terrestrial sources, and decomposition of calcareous organisms (e.g., Emery 1960). The analysis of parameters such as sediment grain size and relative percentages of different sediment fractions (e.g., sand, silt and clay) can provide useful information concerning current velocity, amount of wave action and overall habitat stability in an area. Further, understanding sediment grain or particle size distributions allows for better interpretations of the interactions between benthic organisms and the environment. For example, differences in sediment composition (e.g., fine vs. coarse particles) and associated levels of organic loading at specific sites can affect burrowing, tube building and feeding abilities of infaunal invertebrates, thus leading to changes in benthic community structure (Gray 1981, Snelgrove and Butman 1994).

The chemical composition of sediments can be affected by the geological history of an area. For example, erosion from cliffs and shores, and the flushing of sediments and other debris of terrestrial origin from bays, rivers and streams can contribute to the deposition and accumulation of metals in an area and also affect the overall organic content of sediments. Additionally, nearshore primary productivity by marine plankton contributes to organic input in marine sediments (Mann 1982, Parsons et al. 1990). Finally, particle size composition can affect concentrations of chemical constituents within sediments. For example, the levels of organic materials and trace metals within seafloor sediments generally rise with increasing amounts of fine particles (Emery 1960, Eganhouse and Vanketesan 1993).

Analysis of grain size distributions and the dispersion of sediment particles are useful tools for understanding the hydrodynamic regime of the associated benthos, while other physical properties (e.g., size, shape, density, mineralogy) influence and interact with organic constituents to create new conditions in sediment carbon coupling at the boundary layer. Municipal wastewater outfalls are one of many anthropogenic factors that can directly influence the composition and distribution of sediments through the discharge of treated effluent and the subsequent deposition of a wide variety of organic and inorganic compounds. Some of the most commonly detected compounds discharged via ocean outfalls are trace metals, pesticides and various organic compounds (e.g., organic carbon, nitrogen, sulfides) (Anderson et al. 1993). Moreover, the presence of large outfall pipes and their associated ballast materials (e.g., rock, sand) may alter the hydrodynamic regime in surrounding areas.

This chapter presents summaries and analyses of sediment grain size and chemistry data collected during 2007 at monitoring sites surrounding the South Bay Ocean Outfall (SBOO). The primary goals are to: (1) assess possible effects of wastewater discharge on benthic habitats by analyzing spatial and temporal variability of various sediment parameters, (2) determine the presence or absence of sedimentary and chemical footprints near the discharge site, and (3) evaluate overall sediment quality in the region.

Materials and Methods

Field Sampling

Sediment samples were collected at 27 benthic stations surrounding the SBOO (**Figure 4.1**). These stations range in depth from 18 to 60 m distributed along or adjacent to four main depth contours. Two surveys were conducted in 2007, one during the winter (January-March) and one in the summer (July). Although winter sampling is typically targeted for January, the nine stations located south of the USA/Mexico border could not be sampled until March due to delays in receiving permission to sample in Mexican waters. Each sediment sample was collected from one-half of a chain-rigged 0.1-m^2 double Van Veen grab; the other grab sample was used for macrofaunal community analysis (see Chapter 5). Sub-samples for various analyses were taken from the top 2 cm of the sediment surface and handled according to EPA guidelines (USEPA 1987).

Laboratory Analyses

All sediment chemistry and grain size analyses were performed at the City of San Diego's Wastewater Chemistry Services Laboratory. Particle size analysis was performed using a Horiba LA-920 laser scattering particle analyzer, which measures particles ranging in size from 0.00049 to 2.0 mm (i.e., 11 to -1 phi). Coarser sediments (e.g., coarse sand, gravel, shell hash) were removed prior to analysis by screening the samples through a 2.0-mm mesh sieve. These data were expressed as "% Coarse" of the total sample sieved.

Output from the Horiba particle size analyzer was categorized as follows: sand was defined as particles ranging from >0.0625 to 2.0 mm in size, silt as particles from 0.0625 to 0.0039 mm, and clay as particles <0.0039 mm (see **Table 4.1**). These data

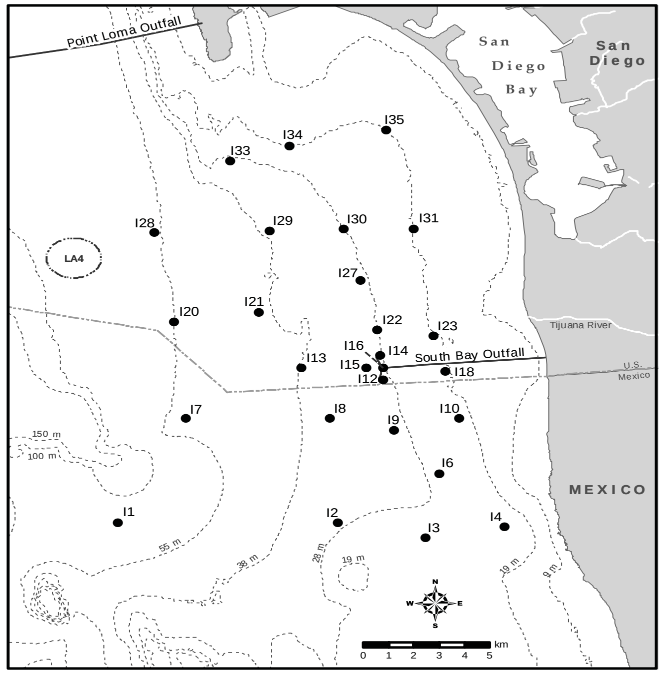

Figure 4.1
Benthic station locations sampled for the South Bay Ocean Outfall Monitoring Program.

were standardized and combined with any sieved coarse fraction (i.e., particles >2.0 mm) to obtain a distribution of coarse, sand, silt, and clay totaling 100%. The coarse fraction was included with the ≥2.0 mm fraction in the calculation of various particle size parameters, which were determined using a normal probability scale (see Folk 1968). These parameters were summarized and expressed as overall mean particle size (mm), phi size (mean, median, skewness, and kurtosis), and the proportion of coarse, sand, silt, and clay. The proportion of fine particles (% fines) was calculated as the sum of all silt and clay fractions.

Sediment samples were analyzed for the chemical constituents specified by the NPDES permits under which sampling was performed. These parameters include total organic carbon (TOC), total nitrogen (TN), total sulfides, trace metals, chlorinated pesticides (e.g., DDT), polychlorinated biphenyl compounds (PCBs), and polycyclic aromatic hydrocarbons (PAHs; see **Appendix C.1**). TOC and TN were measured as percent weight (%wt) of the sediment sample; sulfides and metals were measured in units of mg/kg and expressed as parts per million (ppm); pesticides and PCBs were measured in units of ng/kg and expressed as parts per trillion (ppt);

Table 4.1

A subset of the Wentworth scale representative of the sediments encountered in the SBOO region. Particle size is presented in phi, microns, and millimeters along with the conversion algorithms. The sorting coefficients (standard deviation in phi units) are based on categories described by Folk (1968).

Wentworth scale				Sorting coefficient	
Phi size	Microns	Millimeters	Description	Standard deviation	Sorting
-2	4000	4	Pebble	Under 0.35 phi	very well sorted
-1	2000	2	Granule	0.35–0.50 phi	well sorted
0	1000	1	Very coarse sand	0.50–0.71 phi	moderately well sorted
1	500	0.5	Coarse sand	0.71–1.00 phi	moderately sorted
2	250	0.25	Medium sand	1.00–2.00 phi	poorly sorted
3	125	0.125	Fine sand	2.00–4.00 phi	very poorly sorted
4	62.5	0.0625	Very fine sand	Over 4.00 phi	extremely poorly sorted
5	31	0.0310	Coarse silt		
6	15.6	0.0156	Medium silt		
7	7.8	0.0078	Fine Silt		
8	3.9	0.0039	Very fine silt		
9	2.0	0.0020	Clay		
10	0.98	0.00098	Clay		
11	0.49	0.00049	Clay		

Conversions for diameter in phi to millimeters: $D(mm) = 2^{-phi}$

Conversions for diameter in millimeters to phi: $D(phi) = -3.3219\log_{10}D(mm)$

PAHs were measured in units of µg/kg and expressed as parts per billion (ppb). The data reported herein were generally limited to values above the method detection limit (MDL). However, concentrations below MDLs were included as estimated values if the presence of the specific constituent could be verified by mass-spectrometry (i.e., spectral peaks confirmed). A detailed description of the analytical protocols may be obtained from the City of San Diego Wastewater Chemistry Services Laboratory (City of San Diego 2008).

Data Analyses

Values for total PAH, total DDT and total PCB were calculated for each sample as the sum of all constituents with reported values. Values for each individual constituent are listed in **Appendix C.2**. Zeroes were substituted for all non-detects (i.e., null values) when calculating means. Summaries of parameters included detection rates (i.e., total number of reported values/total number of samples), annual means by station, annual means for all stations combined (areal mean), and the maximum value of each parameter during the year. Annual means, as well as maximum values, were compared to means and maximum values for the pre-discharge period (1995–1998). Levels of contamination were further evaluated by comparing the results of this study to the Effects Range Low (ERL) sediment quality guidelines of Long et al. (1995) when available. The National Status and Trends Program of the National Oceanic and Atmospheric Administration (NOAA) originally calculated the ERLs to provide a means for interpreting monitoring data. The ERLs are considered to represent chemical concentrations below which adverse biological effects are rarely observed.

Results

Particle Size Distribution

Sediment particle composition was diverse at benthic sites sampled around the SBOO in 2007. Mean grain size ranged from about 0.07 to 0.78 mm

Table 4.2

Summary of particle size parameters and organic loading indicators at SBOO stations during 2007. Data are annual means per station (n=2); SD=standard deviation; TN=total nitrogen; TOC=total organic carbon; nd=not detected; Pre-discharge period=1995–1998.

	Particle Size						Organic Indicators		
	Mean (mm)	Mean (phi)	SD (phi)	Coarse (%)	Sand (%)	Fines (%)	Sulfides ppm	TN %wt	TOC %wt
19 m stations									
I35	0.071	3.9	1.4	0.0	63.8	36.3	14.03	0.036	0.383
I34	0.518	1.1	1.0	17.3	82.4	0.4	0.12	0.003	0.358
I31	0.115	3.1	0.7	0.0	92.0	8.0	0.64	0.014	0.108
I23	0.118	3.1	0.7	0.0	90.2	9.9	1.68	0.016	0.162
I18	0.113	3.2	0.7	0.0	90.1	10.0	0.97	0.012	0.121
I10	0.119	3.1	0.6	0.0	92.1	7.9	0.17	0.013	0.139
I4	0.503	1.0	0.8	7.4	92.4	0.2	nd	0.007	0.103
28 m stations									
I33	0.123	3.0	1.0	0.0	87.9	12.2	3.63	0.024	0.398
I30	0.097	3.4	0.9	0.0	83.3	16.8	0.39	0.022	0.209
I27	0.102	3.3	0.8	0.0	86.4	13.6	0.40	0.018	0.176
I22	0.108	3.2	1.0	0.0	85.0	15.1	0.84	0.022	0.217
I16	0.166	2.6	0.9	0.0	93.5	6.6	0.11	0.013	0.110
I15	0.325	1.7	1.0	2.7	92.1	5.2	0.20	0.007	0.100
I14	0.107	3.3	0.8	0.0	87.2	12.8	4.11	0.019	0.196
I12	0.309	1.8	0.8	2.7	95.6	1.7	nd	0.005	0.048
I9	0.097	3.4	0.8	0.0	83.8	16.2	0.48	0.010	0.144
I6	0.444	1.2	0.9	6.6	92.6	0.9	nd	0.010	0.127
I3	0.522	1.0	0.7	8.8	91.3	0.0	nd	nd	0.044
I2	0.309	1.7	0.8	2.3	97.1	0.6	nd	0.004	0.043
38 m stations									
I29	0.781	0.4	0.7	20.8	75.9	3.4	nd	0.014	0.244
I21	0.504	1.0	0.7	7.3	92.7	0.0	nd	nd	0.035
I13	0.528	0.9	0.7	8.2	91.9	0.0	nd	nd	0.072
I8	0.345	1.6	1.1	5.4	93.4	1.3	nd	0.014	0.162
55 m stations									
I28	0.233	2.1	1.9	13.2	44.4	41.0	0.08	0.053	0.858
I20	0.647	0.7	0.7	13.9	85.8	0.4	nd	nd	0.041
I7	0.561	0.9	0.9	10.3	87.4	2.3	nd	0.006	0.092
I1	0.137	2.9	0.9	0.0	91.3	8.8	nd	0.021	0.260
Detection rate (%)							44	74	100
2007 area mean	0.296	2.1	0.9	4.7	86.7	8.5	1.03	0.014	0.184
2007 area max	0.816	3.9	2.0	30.0	98.8	41.7	18.80	0.056	0.891
Pre-discharge mean	0.213	2.3	0.8	1.4	87.7	10.2	4.59	0.019	0.143
Pre-discharge max	1.000	4.2	2.5	52.5	100.0	47.2	222.00	0.077	0.638

(**Table 4.2**). There was little difference in intra-station particle size composition between the winter and summer surveys (**Appendix C.3**), and there was no clear relationship between sediment composition and proximity to the outfall during the year (**Figure 4.2**). Overall, sediment composition has been highly variable throughout the region since sampling began in 1995, with no significant changes being apparent following the initiation of wastewater discharge in early 1999 (**Figure 4.3**). Instead, intra-station variability near the outfall and at other monitoring sites is most likely attributable

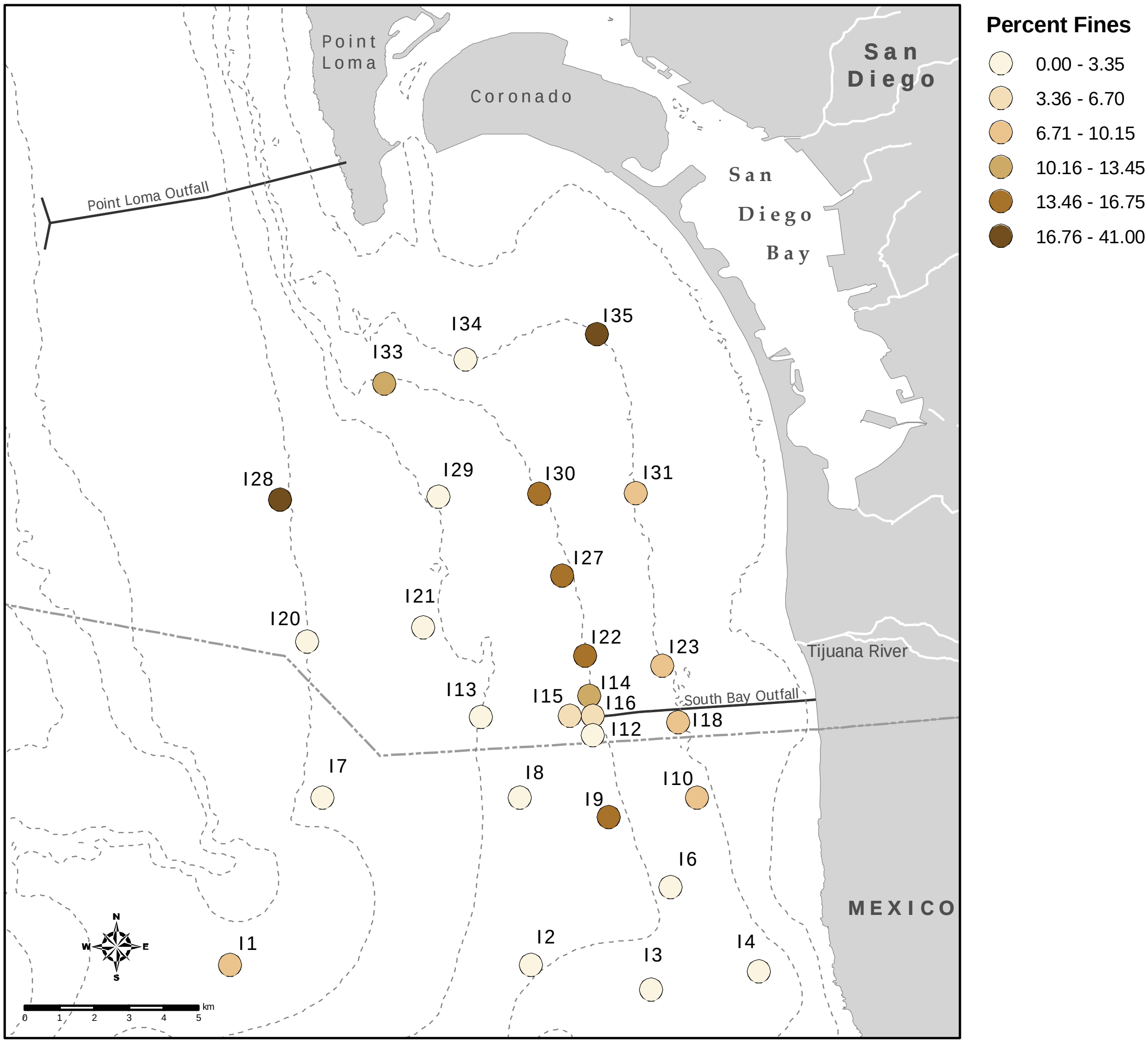

Figure 4.2

Particle size distribution for SBOO benthic stations sampled during 2007. Data are annual means, n=2.

to the different sediment types that occur within the region. For example, the percent fines component (% silt and clay) ranged from 0 to 41% across all SBOO stations in 2007 alone (Figure 4.2). Many sites in the region were also characterized by the presence of different types of coarse sediments, including red relict sands (e.g., stations I7, I13 and I20), black sands (e.g., stations I28 and I29), and shell hash (e.g., stations I2, I3, I4 and I6; see Appendix C.3).

The particle size sorting coefficient reflects the range of grain sizes comprising sediments and is calculated as the standard deviation (SD) in phi size units (see Table 4.1). In general, areas composed of particles of similar size are considered to have well-sorted sediments (i.e., SD≤0.5 phi). In contrast, samples with particles of varied sizes are characteristic of poorly sorted sediments (i.e., SD≥1.0 phi). Sediments in the South Bay region were moderately to poorly sorted in 2007 with sorting coefficients ranging from 0.5 to 2.0 phi (Appendix C.2). Poorly sorted sediments were present at stations I35, I34, I33, I22, I8 and I28 (i.e., SD≥1.0 phi on average; Table 4.2). Of these, station I28 located along the 55-m contour, and station I35 located near the mouth of San Diego Bay, had the highest mean sorting coefficients (SD=1.9 and 1.35 phi, respectively). The sorting coefficients for these two stations have consistently been >1.0 (see City of San Diego 2006).

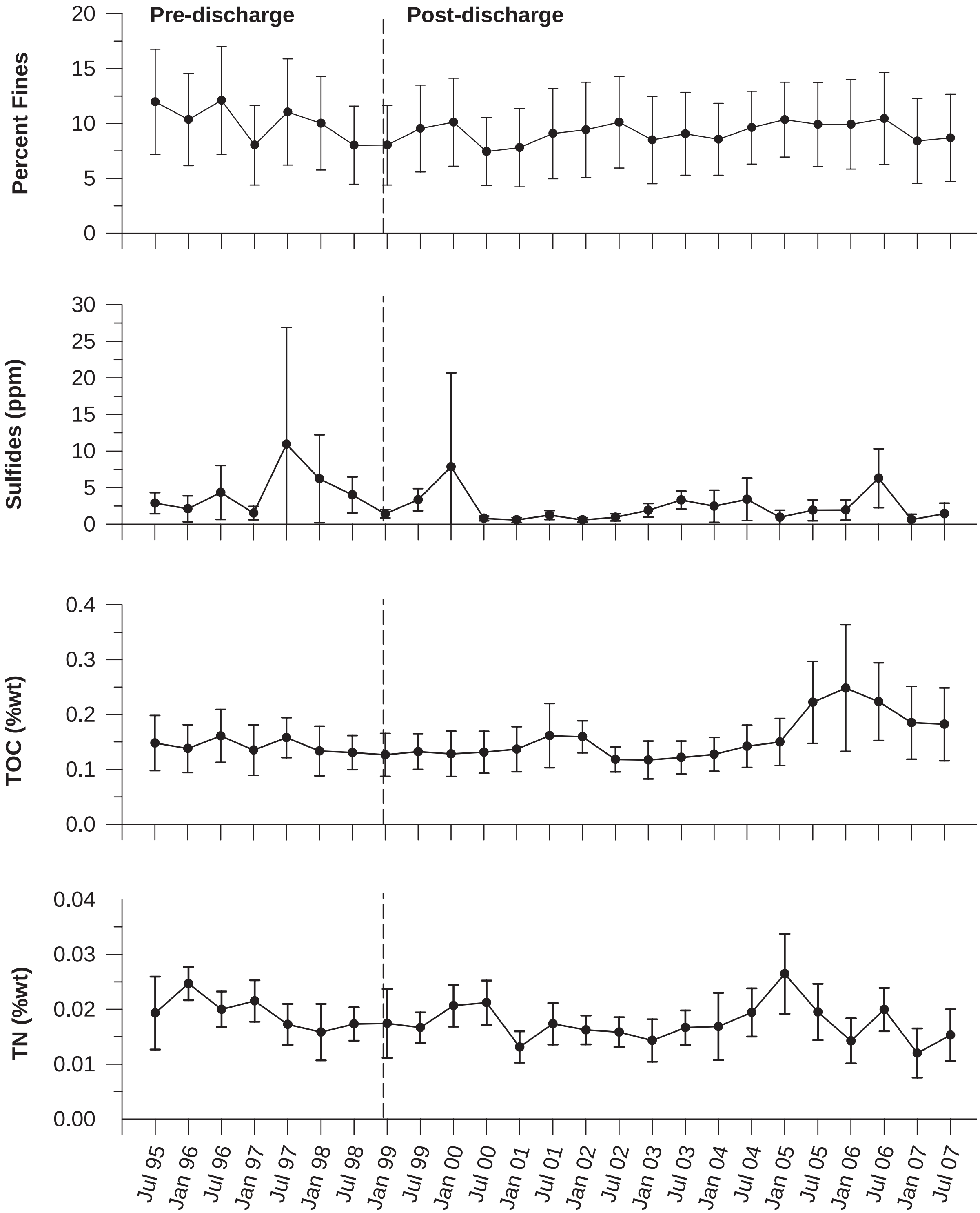

Figure 4.3

Summary of particle size and organic indicator data surrounding the South Bay Ocean Outfall from 1995–2007: TN=total nitrogen, TOC=total organic carbon, %wt=percent weight. Data are expressed as means pooled over all stations for each survey (n=54); error bars represent 95% confidence limits. Some stations from the winter 2007 survey (i.e., January 2007) were actually sampled in March.

Indicators of Organic Loading

Sulfides were detected in 44% of the SBOO samples collected in 2007, with mean concentrations ranging between 0.08–14 ppm per station (Table 4.2). The highest sulfide concentrations occurred in sediments from stations I35 and I14 (14.03 and 4.11 ppm, respectively); I35 is the northernmost 19-m station, while I14 is located near the northern end of the discharge site. In contrast, the three other sites nearest the outfall (i.e., stations I12, I15 and I16) had relatively low sulfide concentrations (≤0.2 ppm). Samples with low sulfide values like these, or perhaps present in concentrations below detection limits (i.e., non-detects), tended to occur in sediments with <10% fines. The maximum reported sulfide value and areal mean for 2007 were lower than detected prior to wastewater discharge. In addition, no major changes appeared to occur in sediments following the initiation of the wastewater discharge in early 1999 (Figure 4.3).

Total nitrogen (TN) and organic carbon (TOC) detection rates were higher than for sulfides at the SBOO stations in 2007 (Table 4.2). TN was detected in 74% of the samples, with concentrations averaging between 0.003 and 0.053% per station. TOC was detected in 100% of the samples, with concentrations averaging between 0.035 and 0.858% per station. With only a few exceptions, TN and TOC concentrations co-varied with higher percentages of fine materials. For example, the highest TN and TOC concentrations were found at station I28, which also had the highest percent fines. As with the sediment composition, there was no clear relationship between TN or TOC concentrations and proximity to the outfall. In addition, mean and maximum values for 2007 were close to or below values reported from the pre-discharge period. There were no major changes in TN or TOC levels following the initiation of wastewater discharge (Figure 4.3).

Trace Metals

Aluminum, arsenic, barium, chromium, iron, manganese, nickel, tin and zinc were detected in 100% of the sediment samples collected in the South Bay region during 2007 (**Table 4.3**). Other metals that were detected in at least 50% of the samples included antimony, copper, lead, silver and thallium. In contrast, mercury, cadmium and selenium were detected less frequently (i.e., 9–41%), while beryllium was not detected at all. Concentrations of each metal were highly variable. For some of the metals, including aluminum, barium, copper, manganese, mercury, nickel and zinc, higher concentrations tended to co-occur at stations with higher proportions of fine particles. Overall, most metals had mean and maximum concentrations in 2007 that were less than pre-discharge values. Exceptions included (a) cadmium, silver and tin, all which exceeded areal mean and maximum pre-discharge values, and (b) antimony, lead, mercury, nickel and thallium, which exceeded just their pre-discharge areal means. Only two metals exceeded environmental threshold values during the year; the ERL for arsenic was exceeded in sediments from a single site located offshore of the SBOO and the ERL for silver was exceeded in sediments from stations located throughout the monitoring area.

Pesticides

Chlorinated pesticides were detected in up to 20 samples collected from 13 different SBOO stations in 2007 (**Table 4.4**, Appendix C.2). Low levels (≤2200 ppt) of BHC (alpha, beta, delta, and gamma isomers), aldrin, and various components of chlordane were detected in sediments from station I16 during the winter survey (Appendix C.2). BHC (gamma isomer) was also detected at station I18 in July. Hexachlorobenzene (HCB) was detected in concentrations ranging from 34 to 340 ppt on average at nine sites (stations I4, I6, I7, I15, I16, I22, I28, I29 and I33) during the year (Table 4.4). Total DDT (primarily p,p-DDE) was detected in sediments from stations I10, I16, I28, I30 and I35, with concentrations ranging between 17 and 579 ppt on average (Table 4.4). Concentrations of total DDT were lower than the ERL (1580 ppt) for this pesticide.

Table 4.3

Concentrations of trace metals (ppm) detected at each SBOO station during 2007. Data are annual means (n=2); ERL=effects range low threshold value; na=not available; nd=not detected; Pre-discharge period=1995–1998. See Appendix C for MDLs and names for each metal represented by periodic table symbol.

Contour	Station	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Ag	Tl	Sn	Zn
	ERL:	na	2.0	8.2	na	na	1.20	81	34	na	46.7	na	0.15	20.9	na	1	na	na	150
19 m	I35	10800	1.2	2.78	48.85	nd	0.20	15.9	4.6	12650	1.80	122.5	0.021	5.6	nd	1.64	0.75	0.9	28.1
	I34	1260	0.8	1.94	6.27	nd	0.06	2.8	0.5	2495	1.05	29.1	nd	0.7	nd	0.07	0.49	0.5	3.9
	I31	4480	0.7	1.11	18.70	nd	0.09	8.3	0.8	4465	0.60	57.8	nd	1.7	nd	1.28	0.85	0.4	7.5
	I23	5425	1.0	1.09	30.20	nd	0.13	9.3	1.2	5805	0.48	65.4	nd	2.5	nd	0.53	0.53	0.8	11.8
	I18	6020	1.3	1.27	37.70	nd	0.17	11.9	1.7	7840	0.52	81.0	nd	2.8	nd	0.91	0.71	1.1	11.8
	I10	6310	1.3	1.32	33.80	nd	0.14	10.6	1.4	6500	0.15	75.9	nd	3.2	nd	1.14	0.39	0.9	16.9
	I4	1125	1.1	1.30	3.47	nd	0.14	5.2	0.5	1820	1.14	14.0	nd	1.1	nd	0.10	0.16	0.8	5.4
28 m	I33	6435	0.2	1.66	26.35	nd	nd	9.8	2.4	7495	4.15	90.6	0.017	2.7	nd	0.91	0.49	1.1	17.8
	I30	8230	1.0	1.66	33.35	nd	0.13	11.9	2.6	7850	0.45	75.1	0.004	4.0	0.128	0.66	0.63	0.5	15.9
	I27	7105	1.1	1.30	29.90	nd	0.12	10.7	1.8	6970	0.55	69.3	0.002	3.2	nd	0.62	0.68	0.5	14.9
	I22	6340	1.1	1.32	27.95	nd	0.13	10.3	1.7	6560	0.77	67.8	0.003	3.3	0.176	0.65	0.52	0.9	13.7
	I16	4475	1.6	1.37	19.30	nd	0.22	8.2	1.7	5560	0.72	57.9	0.002	2.2	nd	0.41	0.59	0.7	10.6
	I15	2240	1.5	2.13	6.14	nd	0.21	8.8	0.4	4890	1.03	28.3	nd	1.4	nd	0.01	0.33	0.8	7.9
	I14	8620	1.0	1.51	40.55	nd	0.12	12.3	2.5	9085	0.29	88.2	0.002	4.2	0.120	1.28	0.73	0.8	19.6
	I12	2745	1.0	1.61	10.63	nd	0.13	7.0	0.5	4405	0.68	35.6	0.001	1.4	nd	0.14	0.63	0.8	8.5
	I9	8875	1.1	1.34	41.95	nd	0.11	12.8	2.3	8155	nd	91.1	0.001	5.0	nd	1.62	0.53	0.8	22.4
	I6	1480	0.9	3.16	5.40	nd	0.08	8.6	0.1	3735	1.45	17.1	nd	1.2	nd	nd	0.16	0.8	6.6
	I3	973	1.1	1.16	2.21	nd	0.16	5.7	0.2	1825	0.91	9.4	nd	0.8	nd	0.08	0.24	0.7	3.4
	I2	1320	1.1	0.80	2.31	nd	0.13	5.7	0.3	1330	0.64	11.5	0.001	0.8	nd	0.08	0.58	0.7	3.8
38 m	I29	4735	0.1	3.13	16.70	nd	nd	10.3	1.4	10495	1.72	55.0	0.001	2.1	nd	0.50	0.36	0.7	14.5
	I21	1615	0.2	9.49	2.80	nd	nd	12.9	nd	9100	2.93	17.3	0.002	0.7	nd	nd	0.36	0.4	8.8
	I13	1245	1.4	6.78	2.41	nd	0.21	10.1	nd	6255	2.11	18.5	nd	0.9	nd	nd	nd	1.5	5.4
	I8	1995	1.1	1.89	4.98	nd	0.13	9.3	0.7	4180	0.88	24.1	nd	1.5	nd	nd	0.28	0.8	10.5
55 m	I28	7480	0.1	2.69	27.85	nd	nd	11.0	4.6	8470	1.92	74.8	0.019	5.0	0.130	0.85	0.89	0.9	19.5
	I20	1720	0.1	3.14	2.89	nd	nd	5.7	nd	5345	1.22	21.0	nd	0.7	nd	nd	0.27	0.6	8.0
	I7	1505	1.0	5.02	3.52	nd	0.10	9.3	0.1	7925	1.90	24.4	nd	1.4	nd	nd	0.26	0.8	6.4
	I1	3585	1.2	1.11	11.60	nd	0.10	7.8	1.0	4410	1.06	51.6	0.004	2.8	0.122	0.50	0.46	0.8	9.2
Detection rate (%)		100	63	100	100	0	41	100	87	100	94	100	37	100	9	56	50	100	100
2007 area mean		4375	0.9	2.34	18.44	0	0.11	9.3	1.3	6134	1.15	50.9	0.003	2.3	0.025	0.52	0.48	0.8	11.6
2007 area max		11200	3.0	9.92	51.10	0	0.446	17.0	4.8	12800	6.52	125	0.027	6.3	0.352	3.12	1.71	2.8	30.3
Pre-discharge mean		5164	0.08	2.47	na	0.13	nd	10.2	2.6	6568	0.09	55.4	0.002	1.9	nd	nd	0.20	nd	12.5
Pre-discharge max		15800	5.6	10.90	54.30	2.14	0.40	33.8	11.1	17100	6.80	162.0	0.078	13.6	0.620	nd	17.0	nd	46.9

PCBs and PAHs

PCBs were detected in sediments from only five SBOO stations during 2007 (Table 4.4). Overall, only 9% of the samples collected had detectable levels of PCBs, all of which were sampled during the winter survey. No PCBs were detected in any sample from the summer July survey. PCBs were most common in sediments at station I18, which had a total PCB concentration of 108,790 ppt comprised of 31 different congeners (Appendix C.2). PCBs were also detected in sediments from stations I2, I4, I28 and I35, although at much lower total PCB concentrations (i.e., ≤85 ppt on average; Table 4.4). Total PCBs at all four of these sites were comprised of three or fewer congeners (Appendix C.2)

In contrast to PCBs, low levels of various PAH compounds were detected in all samples analyzed for 2007 (Table 4.4). Total PAH values were all below the ERL of 4022 ppt. The most prevalent PAH compounds were 1-methylnapthalene, 2,6-dimethylnapthalene, 2-methylnaphthalene, biphenyl, naphhalene, and phenanthrene (Appendix C.2). Each of these PAHs was detected in at least 50% of the samples. There was no apparent relationship between PAH concentrations and proximity to the outfall discharge site.

Table 4.4

Concentrations of total DDT, hexachlorobenzene (HCB), total PCB, and total PAH at SBOO benthic stations in 2007. DDT, HCB and PCB data are expresed in parts per trillion (ppt), while PAH data are expressed in parts per billion (ppb).

Contour	Station	tDDT	HCB	tPCB	tPAH
19 m	I35	145	—	85	74.1
	I34	—	—	—	52.7
	I31	—	—	—	55.1
	I23	—	—	—	78.0
	I18	—	—	54395	97.1
	I10	17	—	—	83.7
	I4	—	65	26	87.3
28 m	I33	—	175	—	64.9
	I30	27	—	—	76.8
	I27	—	—	—	84.7
	I22	—	120	—	77.0
	I16	100	340	—	73.9
	I15	—	85	—	50.9
	I14	—	—	—	76.0
	I12	—	—	—	65.8
	I9	—	—	—	124.6
	I6	—	145	—	69.4
	I3	—	—	—	80.6
	I2	—	—	58	68.6
38 m	I29	—	185	—	49.1
	I21	—	—	—	37.1
	I13	—	—	—	56.6
	I8	—	—	—	86.7
55 m	I28	579	255	26	85.7
	I20	—	—	—	36.0
	I7	—	39	—	59.5
	I1	—	—	—	110.6
Detection rate (%)		13	20	9	100

Summary and Conclusion

Sediment composition in the South Bay outfall region was diverse in 2007, with particle sizes ranging from very fine to very coarse. The diversity of sediment types may be partially attributed to the multiple geological origins of red relict sands, shell hash, coarse sands, and other detrital materials (Emery 1960). In addition, sediment deposition from the Tijuana River and to a lesser extent from San Diego Bay may contribute to the higher content of silt at some of the stations near the outfall, and to the north (see City of San Diego 1988). There was no evident relationship between sediment composition and proximity to the outfall discharge site.

Concentrations of various contaminants, including indicators of organic loading (e.g., sulfides, TN, TOC), trace metals, pesticides (e.g., DDT), PCBs and PAHs in the region remained relatively low compared many other areas of the southern California continental shelf (see Schiff and Gossett 1998, Noblet et al. 2003). Concentrations of sulfides, TN and TOC, as well as several metals, tended to be higher at sites characterized by finer sediments. This pattern is consistent with that found in other studies, in which the accumulation of fine particles has been shown to greatly influence the organic and metal content of sediments (e.g., Eganhouse and Venkatesan 1993). Two metals exceeded ERL values for southern California; relatively high concentrations of silver occurred in sediments throughout the region, while arsenic was mostly isolated to sediments from a few stations quite distant from the outfall. Other contaminants were detected rarely or in low concentrations during 2007. For example, PCBs and various chlorinated pesticides were detected at only five and seven stations, respectively, during the year. Although PAHs were detected at all stations, these compounds were present at concentrations below ERLs. Overall, there was no pattern in sediment contaminant concentrations relative to the SBOO discharge site.

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